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[54] **WORKPIECE HOLDING DEVICE AND POLISHING APPARATUS THEREWITH**

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[52] **U.S. Cl.** **451/288**; 451/398; 451/388
[58] **Field of Search** 451/289, 288, 451/286, 287, 290, 388, 398

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[57] **ABSTRACT**

A workpiece holding device enables stable polishing to be performed without sacrificing the structural strength of a top ring or the space necessary for machining a through hole or implanting engaging pins while allowing close contact to be made between a workpiece to a polishing cloth on a polishing tool. The top ring includes a top ring member having a holder plate for holding the workpiece on a front surface and a cover plate attached to a back surface of the holder plate by engaging a depression section formed on a back surface of the holder plate with a protrusion section formed on a front surface of the cover plate. A curved surface bearing unit provided between an end portion of a drive shaft and a back surface of the cover plate couples the drive shaft and the top ring member while permitting motion of the top ring member relative to the polishing tool. At least a portion of the curved surface bearing unit is positioned within the depression section.

22 Claims, 6 Drawing Sheets

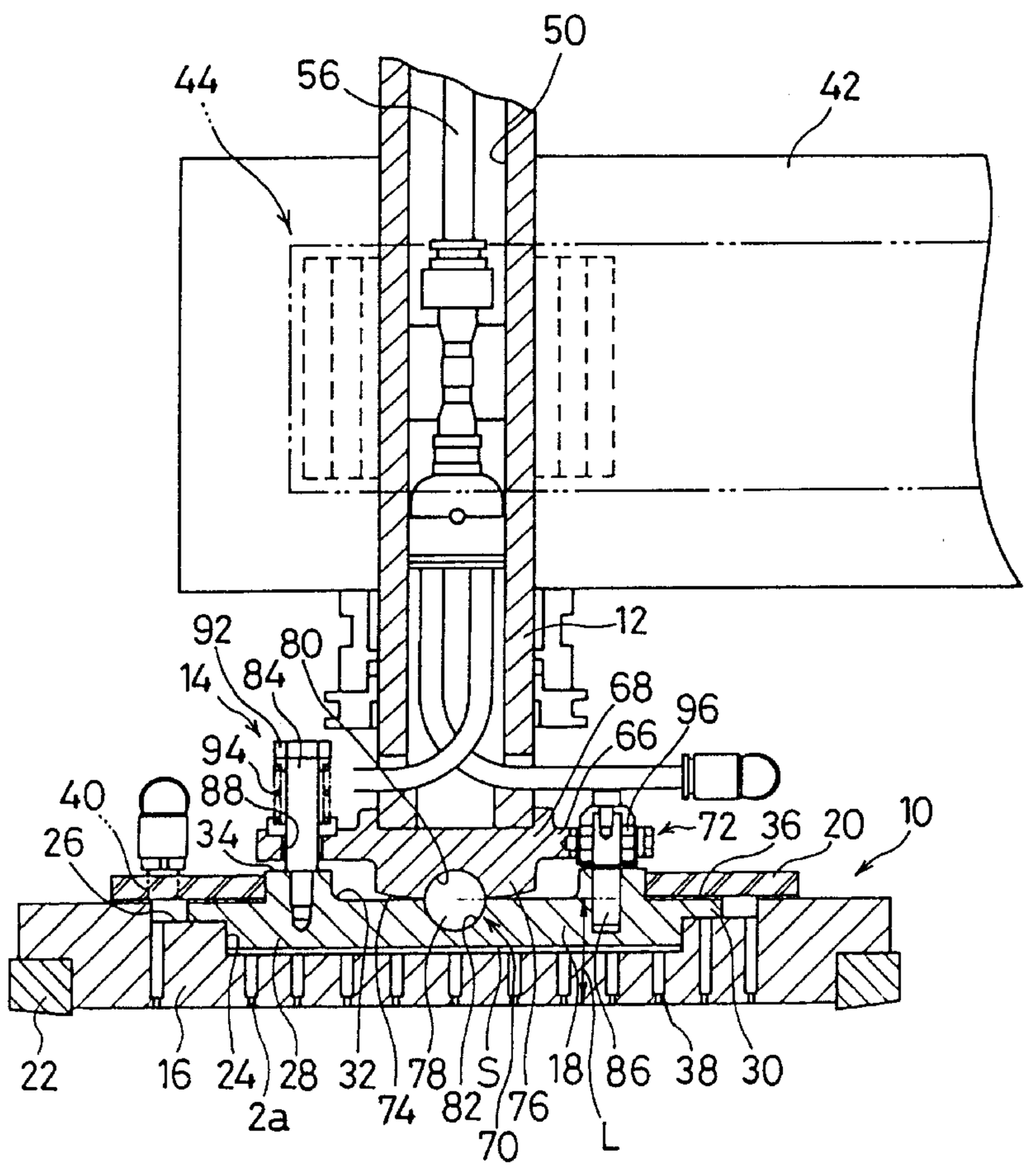

FIG. 1

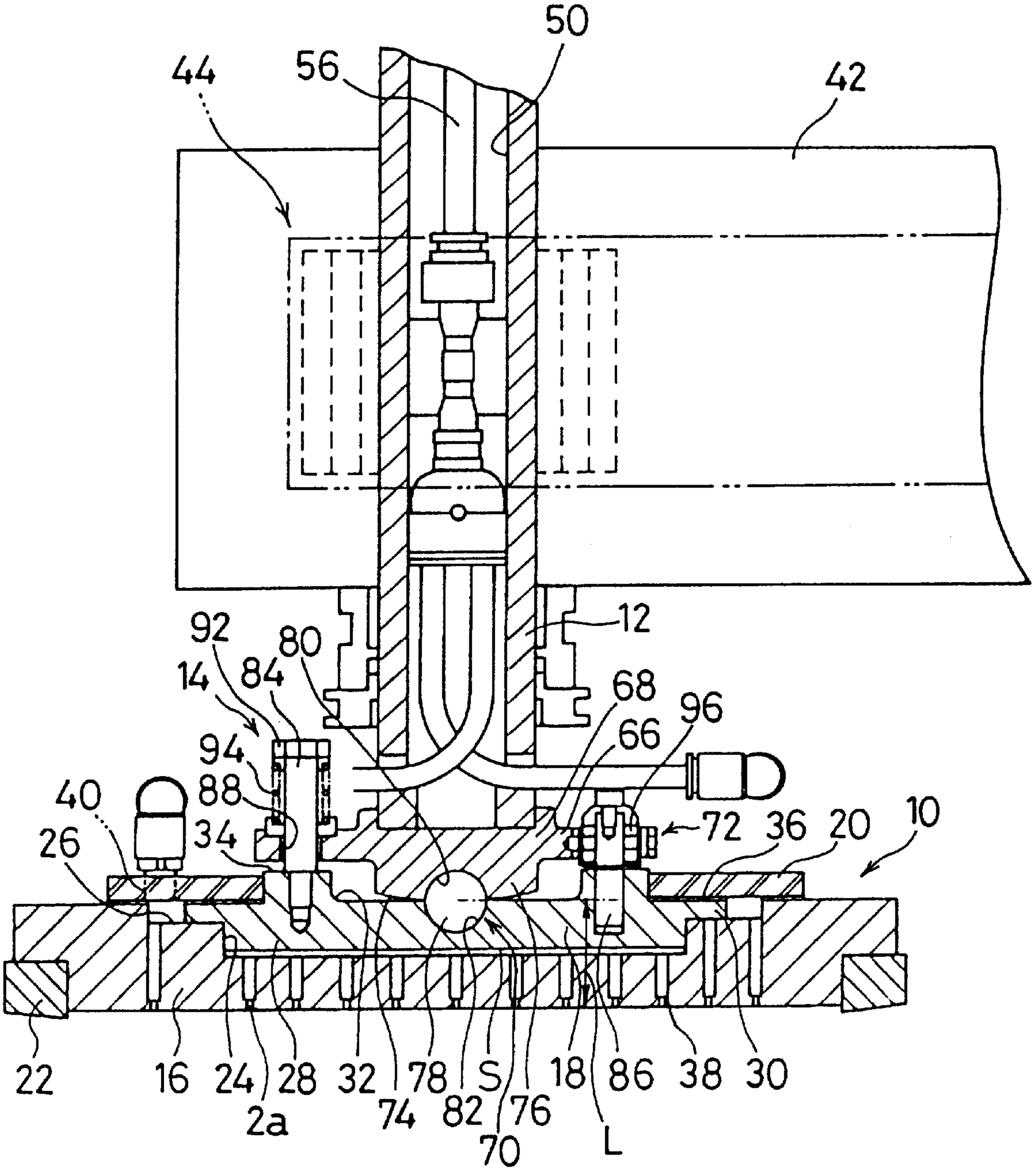
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FIG. 2

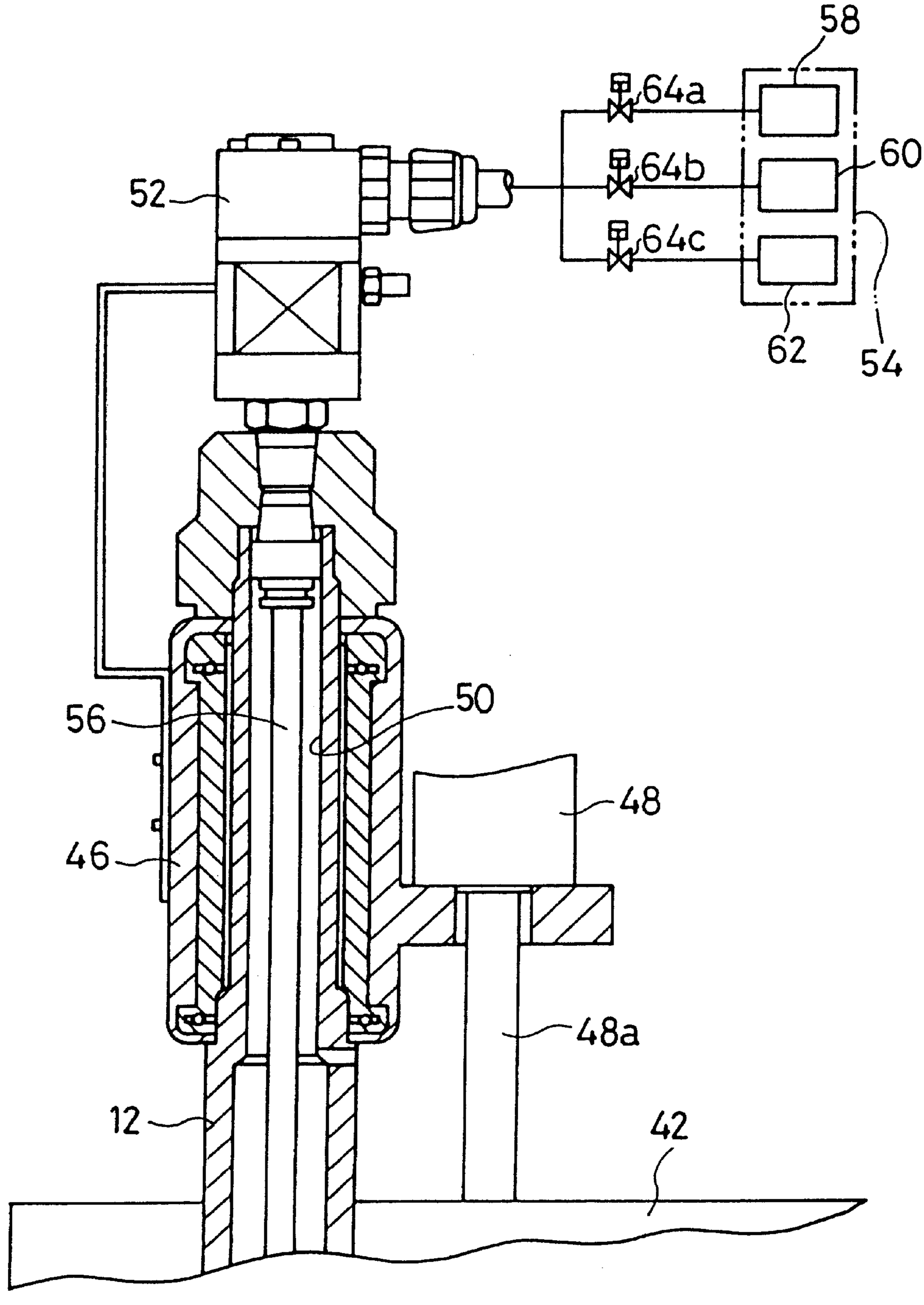


FIG. 3

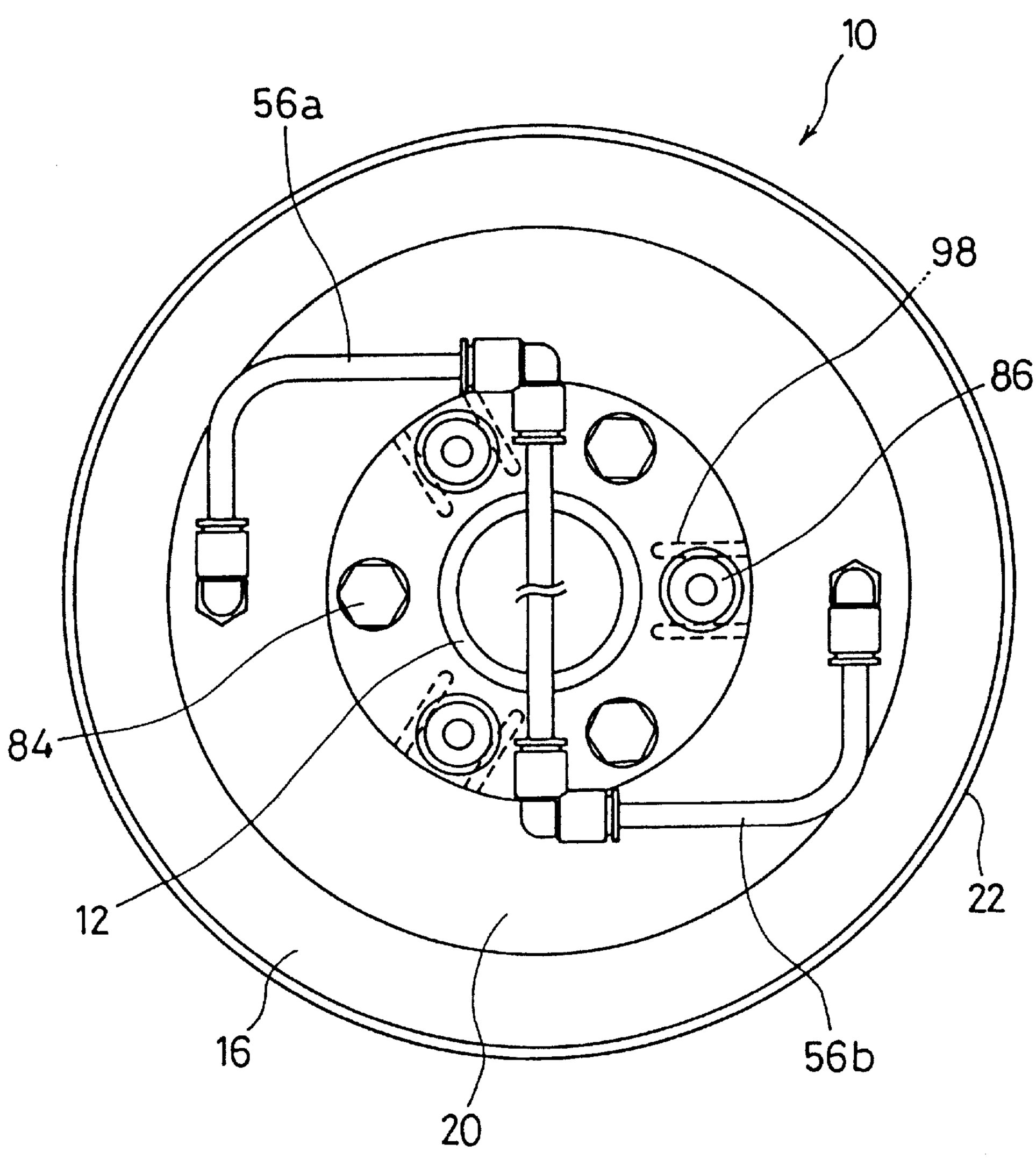


FIG. 4

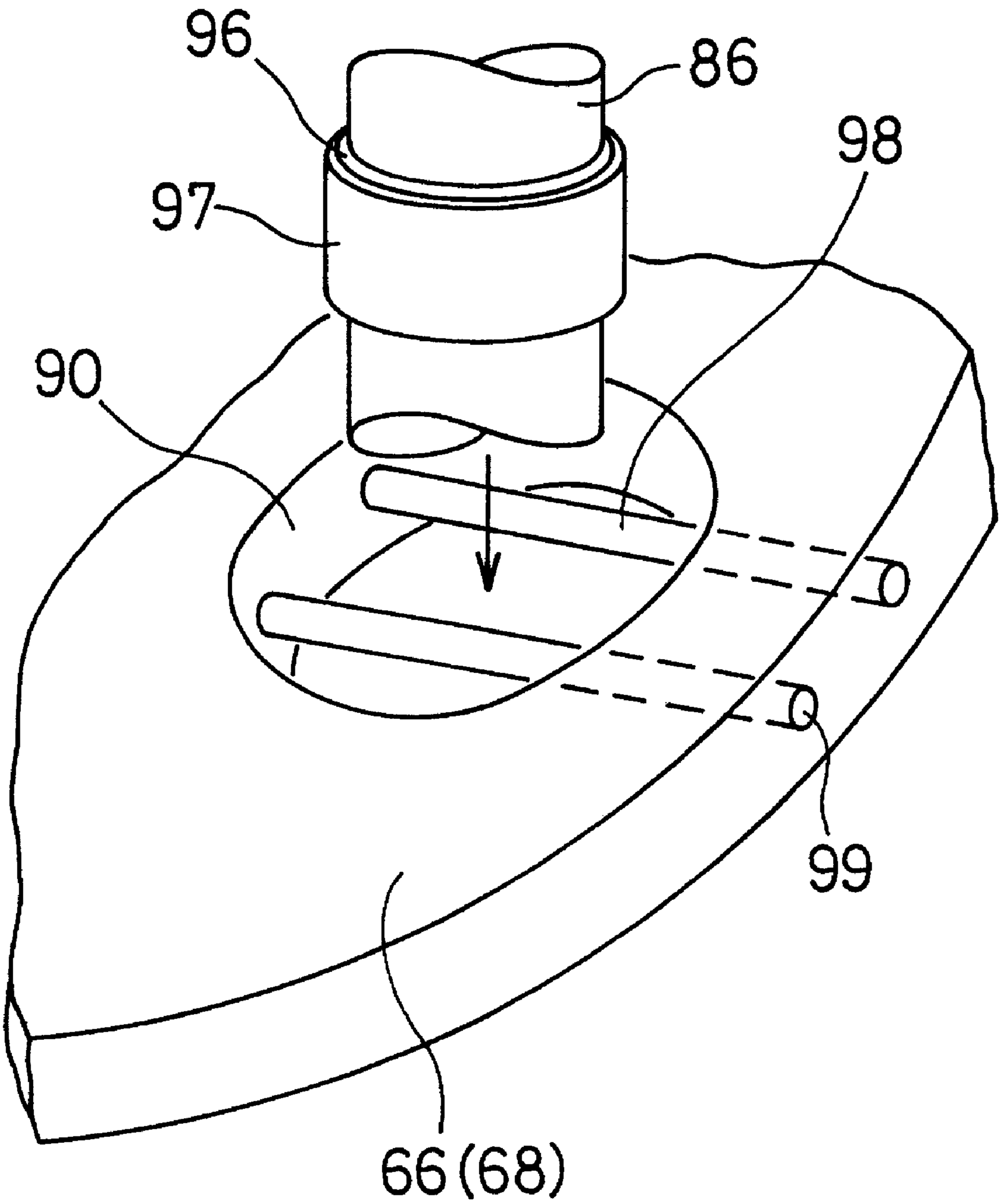


FIG. 5
PRIOR ART

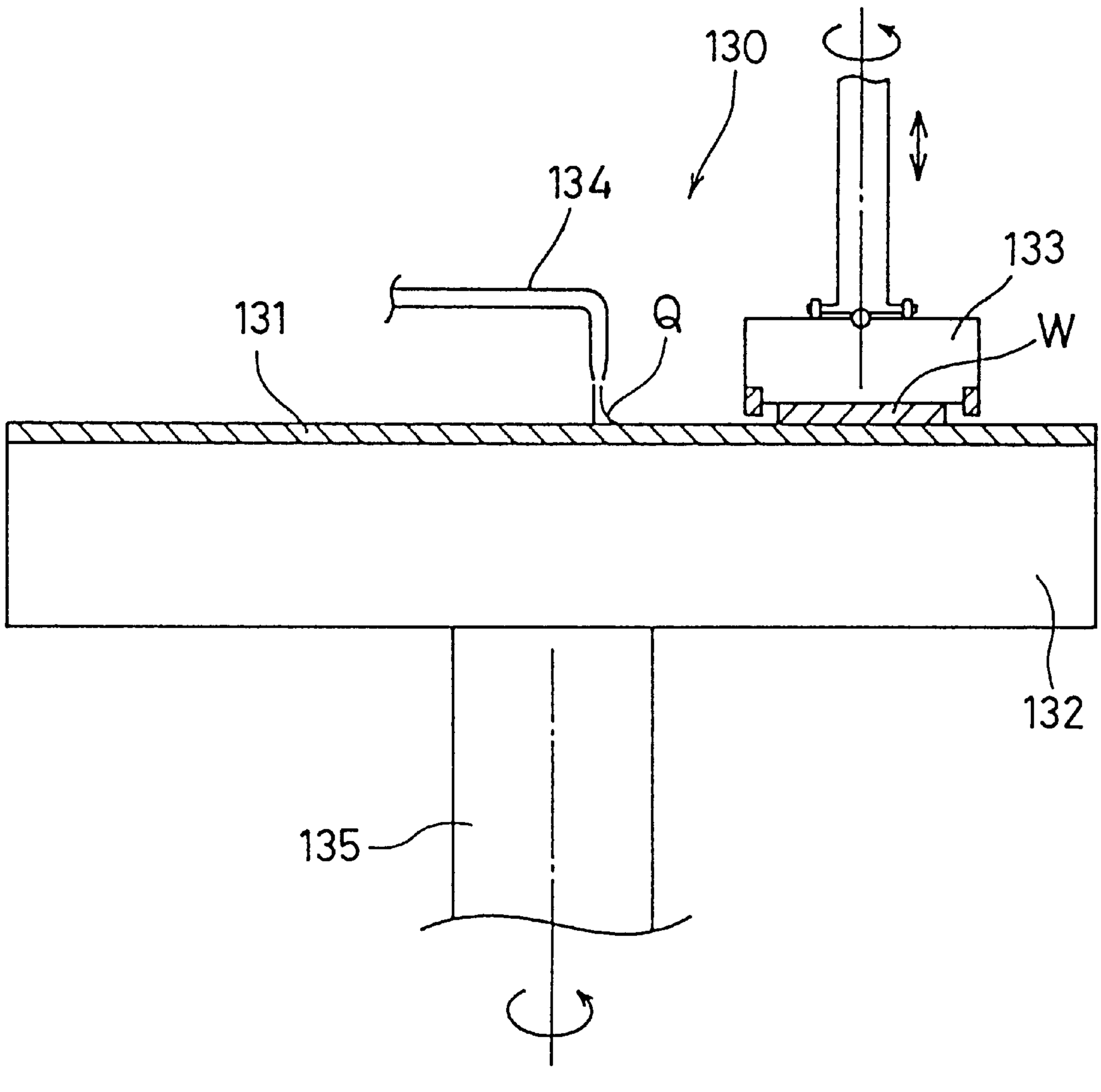


FIG. 6
PRIOR ART

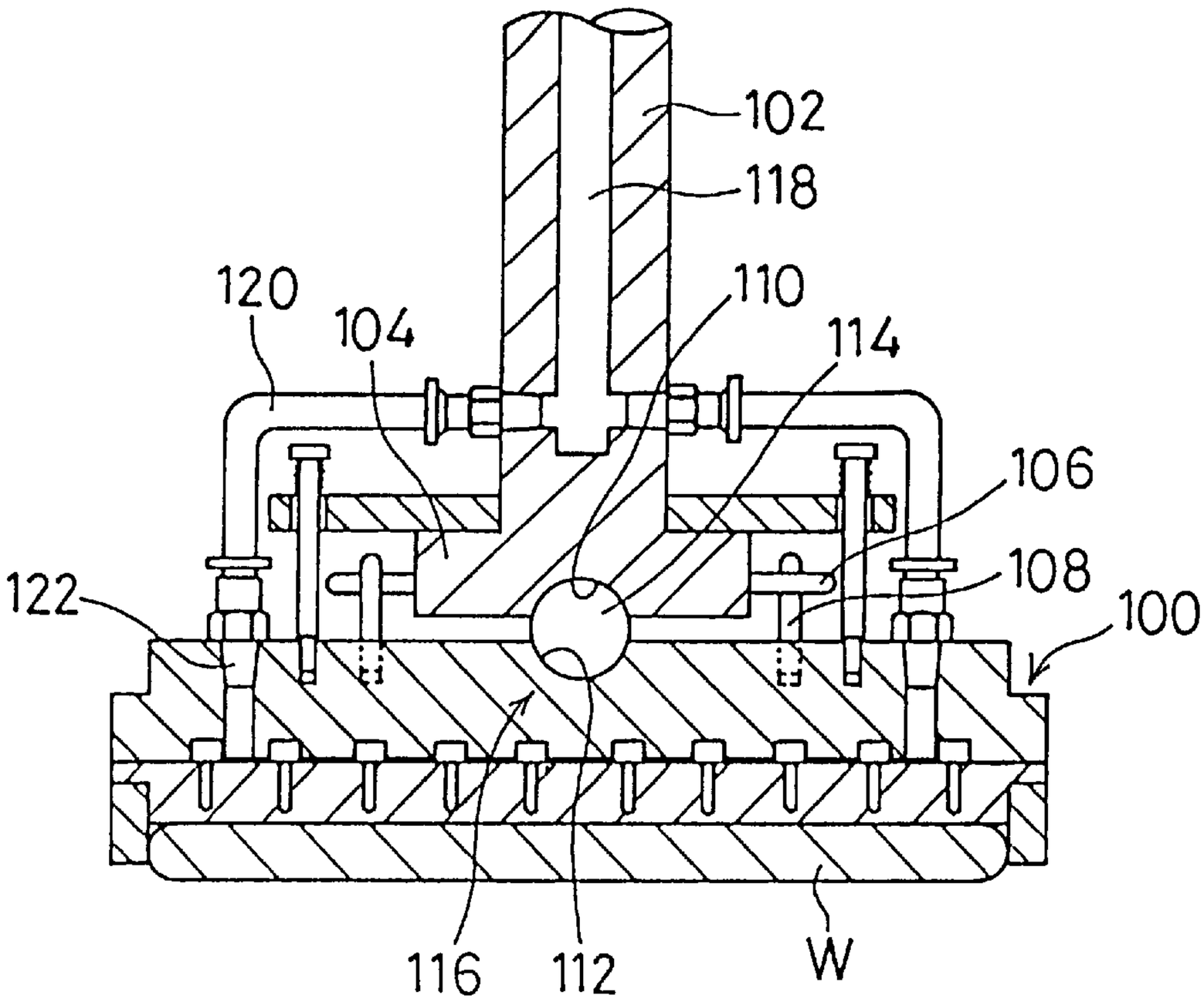
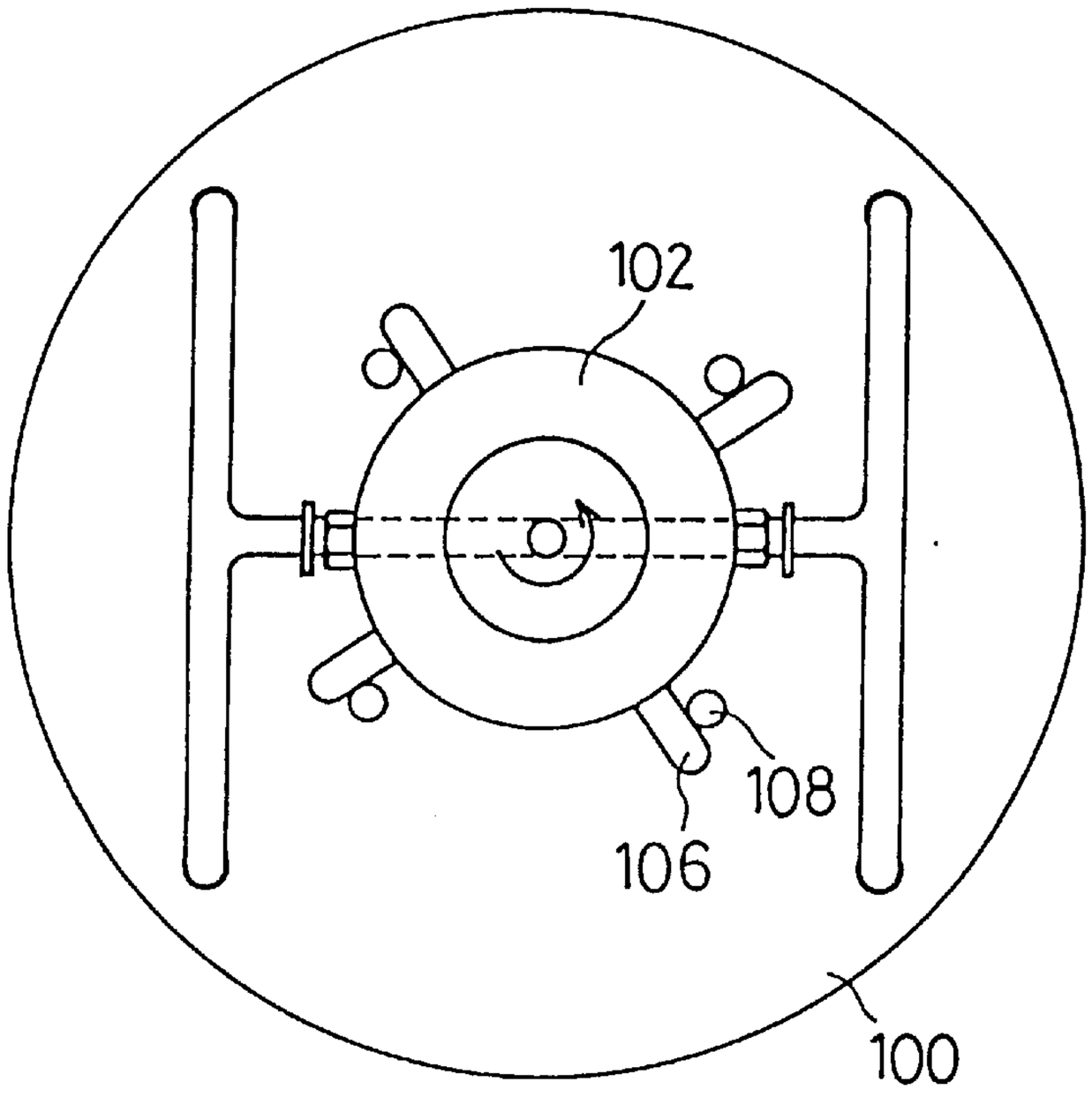


FIG. 7
PRIOR ART



WORKPIECE HOLDING DEVICE AND POLISHING APPARATUS THEREWITH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a workpiece holding device preferably for use in a polishing apparatus for producing a flat mirror surface on a workpiece such as a semiconductor wafer.

2. Description of the Prior Art

In recent years, there has been a remarkable progress in the density of integrated circuit devices leading to a trend of narrowing interline spacing, and, in the case of using optical lithography process involving less than 0.5 μm line spacing particularly, the shallow depth of focus is associated to demand that the focusing plane of the stepper device be highly flat. It then becomes necessary to provide a very flat surface on semiconductor wafer, and one such method is to carry out the planarization using a polishing apparatus.

FIG. **5** shows a conventional polishing apparatus **130** having a turntable **132** with a polishing cloth **131** mounted on its top surface and a top ring **133** for holding a wafer W and pressing it onto the turntable **132**. Polishing is performed by rotating the turntable **132** and the top ring **133** independently while supplying a polishing solution Q from a supply nozzle **134** on the polishing cloth so as to remove the surface material chemically as well as mechanically.

As shown in FIGS. **6** and **7**, for example, the top ring **133** may be a top ring member **100**, disclosed in Japanese Laid-open Patent Publication H6-198561, coupled to a pressing device and a driving device through a drive shaft **102** (spline shaft). A flange section **104** is provided at the lower end of the drive shaft **102** to extend laterally, and a number of radially extending drive pins **106** are provided on the side surface of the flange section **104**. On the top surface of the top ring member **100**, a corresponding number of vertically extending engaging pins **108** are provided so that the rotation of the drive shaft **102** engages the drive pins **106** with the engaging pins **108** to transmit the drive force from the drive shaft **102** to the top ring member **100**.

Also, cavities **110**, **112** each having a spherical inner surface, are provided respectively on the bottom end of the drive shaft **102** and on the top surface of the top ring member **100**, so that a wear resistant ball **114** can be placed to form a spherical bearing device **116**. This spherical bearing device **116** ensures that, even if the turntable becomes tilted with respect to the drive shaft **102**, the top ring member **100** is able to follow such tilt to maintain a close contact between the workpiece and the turntable.

The polishing apparatus of such a construction performs polishing of the workpiece W, by pressing the workpiece W onto the turntable through the top ring member **100** with a certain pressing force while the top ring and the turntable are being rotated to produce a flat and mirror polished surface.

A through hole **118** is provided in the center section of the drive shaft **102**, and the top section of the through hole **118** is connected to an external device such as a fluid supply device or suction device, and the bottom section of the through hole **118** is connected to one end of a tube **120** to communicate with the space or region between the top ring member **100** and the workpiece W to be polished. Various operations are performed through the tube **120**, such as handling of a fluid between the external device and the polishing apparatus, vacuum holding of the wafer W on the top ring member **100** or pressing of the wafer W onto the

turntable by providing a high pressure fluid during the polishing operation.

In such a conventional polishing apparatus, because the pressing force of the drive shaft **102** is designed to be transmitted through the spherical bearing **116** provided between the drive shaft **102** and the top ring member **100**, a close contact of the wafer W to the turntable surface can be achieved. At the same time, however, because of the frictional forces acting between the wafer W and the polishing cloth on the turntable, the top ring member **100** is subjected to a turning moment which tends to rotate the structure **100** about the spherical bearing **116**, and, depending on polishing conditions, stable polishing might not be performed.

The turning moment is proportional to the radial distance between the center of the bearing **116** and the polishing surface of the wafer W. Therefore, polishing can be made more stable, for example, by making the top ring member **100** thinner to reduce the turning moment. However, such an approach presents a problem of possible distortion of the top ring member **100** due to lowering of the stiffness thereof, as well as other problems related to shortage of space for fabricating a connection hole **122** between the tube and the inner space of the top ring member **100** or embedding the drive pins **108** in the top ring member **100**, resulting in difficulties in such fabrications or reduction of the structural strength of the top ring.

Also, because the pressing force by the drive shaft **102** is transmitted through the spherical bearing **116** in the conventional polishing apparatus, the wafer W can be pressed closely against the turntable surface. However, even though the arrangement allows a high degree of freedom for tilting, because only one drive pin on the top ring side engages with one engaging pin on the drive shaft side, if the rotation of the top ring becomes unstable for any reason, the contact between the two pins becomes erratic and the transmission of rotating force becomes unstable so as to compound the rotational instability of the top ring.

Furthermore, the conventional polishing apparatus has a metallic drive shaft **102** with through hole **118** in its center section. If there are pin holes in the inner surface of the through hole **118**, application of an anti-rusting coating on the surface of the through hole **118** does not provide sufficient coverage to prevent rust formation. In such a case, pure water directed to the wafer through the through hole **118**, into the space between the top ring member **100** and the wafer W, becomes contaminated with rust substances, causing a danger of degrading the properties of the wafer product.

SUMMARY OF THE INVENTION

It is a first object of the present invention to provide a workpiece holding device to enable stable polishing to be performed without sacrificing the structural strength of a top ring or the space necessary for machining through hole or implanting a engaging pins while allowing a close contact to be made between the workpiece and a polishing cloth on a turntable.

The first object has been achieved in a workpiece holding device comprising: a top ring member comprising a holder plate for holding the workpiece on a front surface, and a cover plate attached to a back surface of the holder plate by engaging a depression section formed on a back surface of the holder plate with a protrusion section formed on a front surface of the cover plate; a drive shaft for supporting the top ring member while permitting transmission of a pressing force to the top ring member; and a curved surface bearing

unit provided between an end portion of the drive shaft and a back surface of the cover plate for coupling the drive shaft and the top ring member while permitting a tilting motion of the top ring member relative to the turntable, wherein at least a portion of the curved surface bearing unit is positioned within the depression section.

In the present polishing apparatus, the curved surface bearing unit is disposed closer to the turntable, by designing the top ring to be thinner by having a depression section on the cover plate side, and positioning at least a portion of the bearing unit within the depression section. Therefore, the turning moment exerted by the turntable on the workpiece is reduced to stabilize the attitude of the workpiece. Further, the depression section of the holder plate and the protrusion section in the cover plate mate together so that stiffness of the top ring is not compromised. The present workpiece holder device thus makes it possible to carry out stable polishing of a workpiece without sacrificing any of the important factors such as: maintaining the material requirements for making flow holes and other parts in the top ring and close contact between the polishing cloth and the workpiece. The curved surface bearing unit is usually a spherical bearing, but other bearing configurations can be adopted depending on the conditions.

In the above polishing apparatus, another depressed area may be formed on a back surface of the cover plate, and another protruded area may be formed on the bottom end of the drive shaft for inserting into the depressed area, so that the curved surface bearing unit is included between the depressed area and the protruded area. This arrangement allows a reduction in the thickness in the center region, thereby further improving the stabilizing effect.

A second object is to provide a workpiece holding device to enable stable polishing to be carried out by reliably transmitting the drive force from the drive shaft to the top ring while retaining the freedom of tilting motion between the top ring and the drive shaft.

The second object has been achieved in a workpiece holding device comprising: a top ring member for holding a workpiece; a drive shaft for supporting the top ring member so as to freely enable tilting of the top ring member by way of a curved surface bearing unit; and a force transmission mechanism disposed between a bottom end of the drive shaft and the top ring member for transmitting a rotational force from the drive shaft to the top ring member, wherein the force transmission mechanism includes a drive member extending in a given direction from a drive shaft side, and a driven member extending from a top ring member side to an engaging location to engage with the drive member when the drive shaft is rotated, and wherein at least one of the drive member and the driven member is arranged to contact the other member from opposite sides in a circumferential direction so as to restrict a relative circumferential movement of the top ring member with respect to the drive shaft.

This configuration allows reliable transmission of drive force from the drive shaft to the top ring member without disengaging the contact between the drive member and the driven member. The dimensions, shape and orientation of the drive and driven members may be changed in various ways, but generally, pin shapes are used. It is preferable that the material of construction be sufficiently stiff to enable reliable force transmission while allowing free tilting movement by some elastic deformation.

These members are preferably engaged in a crossing manner. Usually, the drive member extends radially outwards, and the driven member extends upwards from the top surface of the top ring. One set of drive and driven members is sufficient, but two or more number of sets of members may be distributed equidistantly around the circumferential periphery to improve transmission stability.

The drive member and the driven member may be in point contact with each ridge line. In this case, the degree of freedom of tilting motion can be enhanced, and especially, tilting in the vertical direction of the drive shaft and twisting including circumferential displacement may be accommodated to some degree.

The drive member and the driven member may be in contact through an elastic cushioning member. In this case, the degree of freedom of tilting movement is retained and vibrations can be absorbed by elastic deformation of the cushioning member to stabilize the workpiece holding capacity of the top ring member.

One member may be embedded into a hole provided for loosely fitting the other member therein. In so doing, these members do not extend out of the apparatus to interfere, and positioning and construction of the other member are simplified, and the production cost of the polishing apparatus can be lowered.

It is a third object of the present invention to provide a workpiece holding device that enables clean water to be delivered therethrough so as to prevent contamination of the workpiece.

The third object has been achieved in a workpiece holding device comprising: a top ring member for holding a workpiece; a drive shaft for supporting the top ring member so as to freely enable tilting of the top ring member by way of a curved surface bearing unit; and a force transmission mechanism disposed between an end portion of the drive shaft and the top ring member for transmitting a rotational force from the drive shaft to the top ring member, wherein a through hole is formed in a central region of the drive shaft, and a fluid tube is inserted into the through hole in such a way that one end of the fluid tube is communicated with an external device including a fluid supply source and an opposite end of the fluid tube is communicated with a space formed between the top ring member and the workpiece.

According to the workpiece holding device, a through hole is provided through the center section of the drive shaft and a fluid tube made of a suitable material, different than the drive shaft material, is provided within the through hole, and pure water is delivered through the fluid tube to the space between the top ring and the workpiece or substrate so that mixing of rust in the water is prevented, and contamination of the workpiece is prevented, thereby improving the physical precision of polishing as well as its quality of chemical purity.

In the above device, the fluid tube may be made of a corrosion resistant and flexible material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross sectional view of an embodiment of the polishing apparatus of the present invention.

FIG. **2** is a cross sectional view of the upper section of the apparatus shown in FIG. **1**.

FIG. **3** is a plan view of the essential parts of the apparatus shown in FIG. **1**.

FIG. **4** is a perspective view of the embodiment shown in FIG. **1**.

FIG. **5** is a schematic cross sectional view of a conventional polishing apparatus.

FIG. **6** is a cross sectional view of a top ring in the conventional polishing apparatus.

FIG. **7** is a plan view of the apparatus shown in FIG. **6**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the workpiece holding device for use in a polishing apparatus will be presented in the following with reference to FIGS. **1** to **4**. The workpiece holding device comprises a top ring member **10** of an overall disc shape, a drive shaft **12** for supporting the top ring member **10** and transmitting rotational and pressing forces to the top ring member **10**, and a universal joint **14** joining the drive shaft **12** to the top ring member **10** in such a way as to accommodate tilting motion of the top ring member **10** relative to the drive shaft **12**. In the following presentation, horizontal surfaces of various component parts are referenced such that a lower surface closer to the workpiece is the front surface and an upper surface away from the workpiece is the back surface. Upper and lower surfaces thus correspond to back and front surfaces, respectively.

Each of these sections will be explained in more detail in the following.

In this embodiment, the top ring member **10** comprises a holder plate **16** of a generally disc shape for holding a workpiece such as a wafer by means of a suction force, a cover plate **18** of a generally disc shape fixed to the holder plate **16** so as to form a space S on the upper side of the holder plate **16**, and a fixing plate **20** of a hollow disc shape for covering the cover plate **18** and fixing the same to the holder plate **16**. A guide ring **22** is attached to the lower outer periphery of the holder plate **16** for surrounding the outer periphery of the workpiece when the holder plate **16** holds the wafer on its lower surface.

A depression or depression section **24** is formed in the upper surface (back surface in relation to the front surface which holds the workpiece) of the holder plate **16** and a step surface **26** is formed around the outer periphery of the holder plate **16**. On the other hand, a protrusion or protrusion section **28** for fitting into the depression section **24** is formed in the center region of the front surface of the cover plate **18**, and a thin flange or flange section **30**, to be fixed to the step surface **26** with bolts, is provided around the periphery or peripheral section of the cover plate **18**. The upper (back) surface of the cover plate **18** has a central depressed area **32** and a ring shaped shoulder or shoulder section **34** surrounding its periphery, and an outer region forms a step surface **36** for attaching the fixing plate **20**.

The depth of the depression section **24** in the holder plate **16** is made to be larger than the height of the protrusion section **28** in the cover plate **18**, thereby forming a spacing S of a certain thickness between the depression section **24** and the protrusion section **28**. The holder plate **16** has a large number of flow holes **38** formed vertically through the plate **16**, and they are communicated with a fluid hole **40** in the fixing plate **20** by way of the space S formed between the cover plate **18** and the holder plate **16**. The flow holes **38** are communicated with the back surface of the workpiece held on the front surface of the holder plate **16**. The space S, as described in more detail later, is for retaining a back side pressure therein, and when it is connected to an evacuation device, it produces a suction force, and when it is connected to a pressure fluid source, it produces a pressing force.

The drive shaft **12** is supported by top ring head section **42**, which is fixed to the polishing apparatus, so as to be freely rotatable and vertically movable, and is coupled to an output shaft of the drive source (motor with reduction gears, not shown) through a pulley belt device **44**. The vertical movement is produced by the action of a piston rod **48***a* in top ring cylinder **48** disposed between the top ring head section **42** and drive shaft holder **46** (refer to FIG. **2**). Specifically, the main body of the top ring cylinder **48** is fixed to a shoulder section of the drive shaft holder **46**, and the tip of the piston rod **48***a* is fixed to the lower surface of the top ring head section **42**.

The drive shaft **12** is formed as a hollow member, and a through hole **50** formed in its center section is communicated with an external pressure source apparatus **54** via a rotary joint **52**. A corrosion resistant fluid tube **56**, made of a polymeric resin such as Teflon or polypropylene, is inserted inside the through hole **50**. The top end of the fluid tube **56** is connected to rotary joint **52** and the bottom end thereof is divided into separate tubes **56***a*, **56***b* (FIG. **3**) which are connected to fluid holes **40** in the fixing plate **20**. In this design, the pressure fluid is supplied through the rotary joint **52** to the top end of the through hole **50** so that there is no need to provide a horizontal hole on the lateral side of the drive shaft **12**, thus resulting in a simplified construction and a lower production cost.

The external pressure source apparatus **54**, in this embodiment, is provided with an evacuation device **58**, a pressurized air source **60** and pure water supply source **62**, each of which can be selectively connected to the flow holes **38** in the holder plate **16** through selection valves **64***a*, **64***b*, **64***c*, rotary joint **52**, delivery tubes **56**, **56***a* and **56***b*. A polishing solution supply nozzle (not shown) is disposed above the turntable to enable a polishing solution to be supplied to the surface of the polishing cloth on the turntable.

A driver plate **68** having an outwardly extending flange or flange section **66** is fixed to the bottom end of the drive shaft **12**. The universal joint **14** is provided between the driver plate **68** and the cover plate **18** of the top ring member **10** for tiltably supporting the top ring member **10** and transmitting the pressing force thereto. The universal joint **14** has a spherical bearing mechanism **70** and a rotation transmission mechanism **72** for transmitting the rotational force of the drive shaft **12** to the top ring member **10**.

The spherical bearing mechanism **70** will be explained first. In the center of the front surface of the driver plate **68**, there is a protruded area **76** formed in such a way that the lower surface makes a gentle spherical surface, and in the center of this protruded area **76**, there is a spherical cavity **80** for freely slidingly retaining a bearing ball **78** made of a high hardness material such as ceramics. The depressed area **32** in the center of the upper surface of the cover plate **18** has width and depth dimensions sufficient to house the protruded area **76** of the driver plate **68**, and in the center of the depressed area **32**, there is also a spherical cavity **82** to pair with the spherical cavity **80** to contain the bearing ball **78**. The bottom end of the bearing ball **78** is positioned inside the depression section **24** of the holder plate **16**, i.e., below the level of the step surface **26**.

By forming the depression section **24** in the holder plate and the protruded area **76** in the cover plate **18** so as to make the top ring thin, and by locating at least a part of the spherical bearing unit within the depression section **24** of the holder plate **16**, it becomes possible to bring the spherical bearing unit close to the turntable. The distance L between the center of the bearing ball **78** and the front surface of the holder plate **16** is designed to be less than 26 mm.

As shown in FIGS. **1**, **3** and **4**, the shoulder section **34** protruding around the depressed area **32** of the cover plate **18** is provided with several pins **84**, **86** (six in this

embodiment) spaced at equal angles, which are inserted into respective holes **88**, **90** provided at corresponding locations in the flange section **66** of the driver plate **68**. These pins **84**, **86** are distributed such that suspending pins **84** for suspending the top ring member **10** and driven pins **86** for transmitting the torque to the top ring member **10** are placed alternately. The suspending pins **84** are protruded out of the upper surface of the driver plate **68**, and a spring **94** is placed between a stopper plate **92** disposed at the top end of the pin and the driver plate **68** so as to support (a part of) the load exerted by the top ring member **10** with the elastic force of the spring **94**.

With reference to FIGS. **3** and **4**, two parallel driver pins **98** are horizontally embedded in holes **90** of the driver plate **68** on opposite circumferential sides of the driven pins **86**. That is, as shown in FIG. **4**, two fine holes **99** are provided in such a way to open at a side surface of the flange section **66** and into hole **90** located on the flange section **66** of the driver plate **68**, and the driver pins **98** are inserted and fixed in these fine holes **99**.

As illustrated in FIG. **4**, the driven pin **86** is provided with a cushion **96**, made of an elastic material such as rubber, around the periphery, and each cushion **96** has a cushion cover **97** on its periphery. Each driver pin **98** touches the outer periphery of the cushion cover **97**. The rotation transmission mechanism **72** thus comprises the driver pins **98** and the driven pins **86** to transmit the torque smoothly and with certainty from the drive shaft **12** to the top ring member **10**.

Next, the operation of the polishing apparatus having the construction presented above will be explained.

By connecting the evacuation device **58** of the external pressure source apparatus **54** to the rotary joint **52**, the workpiece is held on the lower surface of the holder plate **16** by the suction at the flow holes **38** in the holder plate **16**, and drive power is applied to the drive shaft **12** to rotate the holder plate **16**. In this case, because the fluid tube **56** is made of Teflon or polypropylene, it is sufficiently strong so as not to collapse under the stress of evacuation.

With reference to FIG. **2**, the top ring cylinder **48** is operated so that the piston rod **48***a* is pulled into the top ring cylinder **48**, then, because the top ring head **42** is fixed to the polishing apparatus frame, the top ring cylinder **48** is descended together with the drive shaft holder **46**. The workpiece is made to touch the turntable first, and then, it is further pressed against the turntable. The pulling force exerted by the piston rod **48***a* is transmitted to the workpiece in the form of a pressing force by way of the drive shaft **12**, bearing ball **78**, flange section **30** of the cover plate **18** and the holder plate **16**. The workpiece is thus pressed onto the polishing cloth on the turntable with a given pressure. In the meantime, when the top ring member **10** begins to descend, the turntable rotation had already been started and the polishing solution is being supplied through the supply nozzle onto the polishing cloth on the turntable. The surface to be polished (bottom surface) of the workpiece is polished under the existence of the polishing solution so that the polishing process is commenced.

In this polishing operation, because the pressing force from the drive shaft **12** is transmitted through the spherical bearing **70** provided between the drive shaft **12** and the top ring member **10**, even if the vertical alignment of the drive shaft **12** to the cloth surface of the turntable is impaired, for example, the holder plate **16** can tilt about a center at the bearing ball **78** so that the workpiece is kept in close contact with the cloth surface.

Also, because the depression section **24** and the protrusion section **28** are formed to mate with each other in an opposing manner on the respective holder plate **16** and the cover plate **18**, the thickness of the center region of the holder plate **16** is reduced. Also, because a part of the spherical bearing structure resides within the depression section **24**, the distance between the center of the spherical bearing **70** and the workpiece surface is made short. Therefore, the rotational moment about the spherical bearing **70** is also reduced so that the attitude of the workpiece is stabilized. The result is that stable polishing can be carried out without sacrificing the stiffness of the holder plate while maintaining all the essential polishing requirements, such as securing the space necessary for supplying the polishing solution to the top ring member **10** and keeping the workpiece in close contact with the polishing cloth on the turntable.

Furthermore, the distance between the center of the spherical bearing **70** and the workpiece surface is also made short because the bearing ball **78** is provided between the depressed area **32** in the cover plate **18** and the protruded area **76** provided at the bottom end of the drive shaft **12**, which also promotes a stable alignment of the workpiece. Further, the peripheral section of the top ring member **10** has been given a sufficient thickness to provide the shoulder section **34** and the step surface **36**, so as not to sacrifice either the stiffness or the space required for fabricating the connection hole **40** or implanting the driven pins **86**.

In this design of the workpiece holder device, even if the holder plate **16** becomes tilted, the driven pins **86** and the driver pins **98** are relatively movable in the vertical direction so that the rotational torque of the drive shaft **12** is reliably transmitted to the holder plate **16** by simply relocating the contacting points to each other. Also, because the driven pins **86** and the driver pins **98** are in point contact at right angles to each other, friction is low and the freedom of tilting is maintained.

In this embodiment, each driven pin **86** is surrounded with an elastic cushion **96** such as rubber to absorb vibration between the drive shaft and the top ring. Further, the outer surface of the cushion **96** is covered with a tube shaped cushion cover **97**, and the driver pins **98** contact the cushion cover **97** at opposite peripheral sides. Therefore, the driven pins **86** and the driver plate **68** are able to freely move vertically relative to each other while maintaining an elastic contact.

Also, the bottom end surface of the protruded area **76** of the driver plate **68** is formed as a spherical surface (flank) **74** of a large radius of curvature, so that the separation distance from the top surface of the cover plate **18** progressively increases from the center towards the circumference, therefore, even if the spherical cavity **82** is made sufficiently large, there is no mechanical interference between the curved surface **74** and the depressed area **32**, so that the pressing force is transmitted reliably from the drive shaft **12** to the bearing ball **78**.

To assure reliable contact of the workpiece to the polishing cloth, the fluid tube **56** may be switched to air pressure source **60** so that compressed air may be supplied to the back surface of the workpiece through the flow holes **38** and the spacing S.

When the polishing operation is completed, the drive shaft **12** is raised, and the drive plate **68** integral with the drive shaft **12** is also raised, and the cover plate **18** and the top ring member **10** are elastically supported approximately horizontally by way of the springs **94** and the suspending pins **84**. In this state, the top ring member **10** is retracted away from the turntable, and is operated the pressure source

apparatus **54** as needed to hold/detach the workpiece from the top ring member **10** to handle the workpiece between the top ring member **10** and some external device.

By connecting the evacuation device **58** of the external pressure source apparatus **54** to the rotary joint **52**, the workpiece is held on the lower surface of the holder plate **16**, and by connecting the pure water supply source **62** of the external pressure source apparatus **54** to the rotary joint **52**, pure water is made to flow through the fluid tube **56**, space S, and the flow holes **38** in the holder plate **16** to push the back surface of the workpiece to detach the workpiece readily from the holder plate **16**.

In this embodiment, because the holder device is designed so that the pressing force is transmitted from the flange section **30** of the cover plate **18** to the step surface **26** of the holder plate **16**, a uniform pressure can be applied to the holder plate **16** on the total surface of the workpiece, compared with the conventional arrangement in which the pressure is applied through the center of the holder plate through the bearing ball, because the forces are distributed around the periphery of the holder plate **16** to reduce the amount of deflection of the holder plate **16**.

In the present polishing apparatus, the fluid tube **56** is made of a corrosion resistant material, therefore, even when water or air is supplied through the through hole, no rust is formed on its interior. Contamination is thus prevented, and polishing precision as well as the final quality of the polished workpiece can be improved.

Also, in the present embodiment, the driver section and the driven section to transmit the rotational torque from the drive shaft **12** to the holder plate **16** are based on pin contacts. However, the invention is not necessarily limited to such designs. Other possible designs such as plate form and other special forms are also employable. Also, the driver pins **98** to engage the driven pin **86** are disposed parallel in the present embodiment, but they may not be parallel, nor be limited to two pins. Conversely, for example, driver pins may be protruded from the side of a plate **68** and several driven pins may be provided on the top surface of the driven plate **18** so as to hold the driver pin. Also, in the present embodiment, the drive shaft **12** has a separate fixed driver plate **68**, but the drive plate **68** may be formed integrally with the drive shaft **12**.

What is claimed is:

1. A polishing apparatus for producing a mirror finish on a workpiece and including a polishing tool and a workpiece holding device, said device comprising:

a top ring member comprising:

a holder plate having a front surface for holding a workpiece and a back surface having a depression section; and

a cover plate having a front surface having a protrusion section engaging with said depression section and a back surface;

a drive shaft supporting said top ring member and enabling transmission of a pressing force to said top ring member; and

a curved surface bearing unit, provided between an end portion of said drive shaft and said back surface of said cover plate, for coupling said drive shaft and said top ring member while permitting tilting motion of said top ring member relative to a polishing surface of the polishing tool, said unit comprising a spherical bearing including a ball having an entirely spherical configuration, at least a portion of said ball being located at a level within said depression section.

2. An apparatus as claimed in claim **1**, further comprising a transmission device for transmitting rotation of said drive shaft to said top ring member.

3. An apparatus as claimed in claim **1**, wherein said ball is made of a high hardness material.

4. An apparatus as claimed in claim **1**, wherein said back surface of said cover plate has a depressed area, and said curved surface bearing unit extends into said depressed area.

5. A polishing apparatus for producing a mirror finish on a workpiece and including a polishing tool and a workpiece holding device, said device comprising:

a top ring member for holding a workpiece;

a drive shaft supporting said top ring member;

a curved surface bearing unit between said drive shaft and said top ring member to enable tilting of said top ring member; and

a force transmission mechanism between said drive shaft and said top ring member for transmitting a rotational force from said drive shaft to said top ring member, said mechanism comprising:

a drive member extending from said drive shaft;

a driven member extending from said top ring member; and

said drive member and said driven member being positioned to engage each other upon rotation of said drive shaft, with at least one of said drive member and said driven member being positioned to contact the other said member from two sides in a circumferential direction, thereby restricting relative circumferential movement of said top ring member with respect to said drive shaft.

6. An apparatus as claimed in claim **5**, wherein all contact between said drive member and said driven member is point contact.

7. An apparatus as claimed in claim **5**, further comprising an elastic cushioning medium between said drive member and said driven member.

8. An apparatus as claimed in claim **5**, wherein said one member is embedded in a hole into which said other member loosely fits.

9. A polishing apparatus for producing a mirror finish on a workpiece and including a polishing tool and a workpiece holding device, said device comprising:

a top ring member for holding a workpiece with a space therebetween;

a drive shaft supporting said top ring member, said drive shaft having a central region having therein a hole;

a curved surface bearing unit between said drive shaft and said top ring member to enable tilting of said top ring member; and

a force transmission mechanism between said drive shaft and said top ring member for transmitting a rotational force from said drive shaft to said top ring member; and

a fluid tube extending through said hole, said fluid tube having one end to be connected to a fluid supply source and an opposite end to communicate with the space.

10. An apparatus as claimed in claim **9**, wherein said fluid tube is made of a corrosion resistant material.

11. An apparatus as claimed in claim **9**, wherein said fluid tube is made of a flexible material.

12. A workpiece holding device for use with a polishing tool, said device comprising:

a top ring member comprising:

a holder plate having a front surface for holding a workpiece and a back surface having a depression section; and

a cover plate having a front surface having a protrusion section engaging with said depression section and a back surface;

a drive shaft supporting said top ring member and enabling transmission of a pressing force to said top ring member; and

a curved surface bearing unit, provided between an end portion of said drive shaft and said back surface of said cover plate, for coupling said drive shaft and said top ring member while permitting tilting motion of said top ring member relative to a polishing surface of the polishing tool, said unit comprising a spherical bearing including a ball having an entirely spherical configuration, at least a portion of said ball being located at a level within said depression section.

13. A device as claimed in claim **12**, further comprising a transmission device for transmitting rotation of said drive shaft to said top ring member.

14. A device as claimed in claim **12**, wherein said ball is made of a high hardness material.

15. A device as claimed in claim **12**, wherein said back surface of said cover plate has a depressed area, and said curved surface bearing unit extends into said depressed area.

16. A workpiece holding device comprising:

a top ring member for holding a workpiece;

a drive shaft supporting said top ring member;

a curved surface bearing unit between said drive shaft and said top ring member to enable tilting of said top ring member; and

a force transmission mechanism between said drive shaft and said top ring member for transmitting a rotational force from said drive shaft to said top ring member, said mechanism comprising:

a drive member extending from said drive shaft;

a driven member extending from said top ring member; and

said drive member and said driven member being positioned to engage each other upon rotation of said drive shaft, with at least one of said drive member and said driven member being positioned to contact the other said member from two sides in a circumferential direction, thereby restricting relative circumferential movement of said top ring member with respect to said drive shaft.

17. A device as claimed in claim **16**, wherein all contact between said drive member and said driven member is point contact.

18. A device as claimed in claim **16**, further comprising an elastic cushioning medium between said drive member and said driven member.

19. A device as claimed in claim **16**, wherein said one member is embedded in a hole into which said other member loosely fits.

20. A workpiece holding device comprising:

a top ring member for holding a workpiece with a space therebetween;

a drive shaft supporting said top ring member, said drive shaft having a central region having therein a hole;

a curved surface bearing unit between said drive shaft and said top ring member to enable tilting of said top ring member; and

a force transmission mechanism between said drive shaft and said top ring member for transmitting a rotational force from said drive shaft to said top ring member; and

a fluid tube extending through said hole, said fluid tube having one end to be connected to a fluid supply source and an opposite end to communicate with the space.

21. A device as claimed in claim **20**, wherein said fluid tube is made of a corrosion resistant material.

22. A device as claimed in claim **20**, wherein said fluid tube is made of a flexible material.

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